CHAPTER 3

OTHER OBSERVATIONS

3.1 General. In addition to aerial reconnaissance data, the observational systems used in support of the *National Winter Storms Operations Plan* include land surface, ship, radar, buoy, upper air, and satellite data. The routine operations of these various data sources are detailed in the following Federal Meteorological Handbooks and plans:

- Federal Meteorological Handbook No. 1, *Surface Weather Observations and Reports*
- Federal Meteorological Handbook No. 2, *Surface Synoptic Codes*
- Federal Meteorological Handbook No. 3, *Rawinsonde and Pibal Observations*
- Federal Meteorological Handbook No. 11, *Doppler Radar (Parts A, B, C, and D)*
- *Operations of the National Weather Service*
- *Federal Plan for Environmental Data Buoys*
- The *GOES User's Guide* and operational amendments
- *The NOAA Polar Orbiter Data Users Guide*
- *National Operations Plan for Drifting Data Buoys*
- *The Coastal Marine Automated Network (C-MAN) NWS Users Guide*
- *Tide/Water Level Information Data and Evaluation System (TIDES) NWS Users Guide*

Procedures for obtaining special or non-routine observations required in support of winter storm detection and forecasting, while covered to some extent in these documents, are described in detail in *National Weather Service Operations Manual*, Chapter B-90, "Special Warning Program Observations." The chapter covers observational programs of several agencies involved. The only two observational programs that will be covered in any detail here are the two data sources that provide unique capabilities to support winter storm analysis and forecasting.

3.2 Satellite Observations.

3.2.1 Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data, and Information Service (NESDIS).

3.2.1.1 Geostationary Operational Environmental Satellite (GOES). The GOES system consists of two operational spacecraft: GOES-8 at 75 degrees west longitude and GOES-10 (the successor to GOES-9) at 135 degrees west longitude. GOES-8 introduced a 3-axis stabilized geosynchronous satellite to NOAA operations. These satellites ushered in a new era of products and services, providing improved real-time satellite data to the National Weather Service forecast offices and national centers. GOES-11 was launched on May 3, 2000. This new satellite will provide the same capabilities as GOES-8 and GOES-10, and it is stored on orbit at 104 degrees west longitude until required to replace either of the older operational satellites. GOES-9 is located at 106 degrees west longitude as a short term replacement in the event of a catastrophic failure of the other 3 satellites.

3.2.1.1.1 GOES Scan Operations. The spacecraft routinely scans the United States every 15 minutes. A full disk image is scanned every 3 hours and takes nearly 30 minutes to complete. Forecasters now view digital GOES data more frequently and with greater spatial resolution. The digital data provide the user with the flexibility to customize gridding and enhancement curves for the data. The GOES-8 and GOES-10 spacecraft were also designed for flexible scanning of the earth. Any variation of scan or sector coverage at regular time intervals can be scheduled in a 30-minute time frame. Rapid Scan Operations (RSO) and Super-Rapid Scan Operations (SRSO) are available on the current generation of satellites. RSO and SRSO allow for small sections of the earth to be scanned more frequently, at up to 1 minute intervals. However, by doing so, other portions of the earth are scanned with less regularity. Definitions of the GOES RSO and SRSO scanning coverage and scanning times can be found at *www.ssd.noaa.gov*; "click on" GOES Scanning Schedules.

3.2.1.1.1.1 Requests for Special Satellite Sectors. Special RSO and SRSO GOES data on critical severe storm days may be requested via the NCEP Senior Duty Meteorologist (SDM). The SDM will coordinate operational requests through the NESDIS Satellite Services Division (SSD), Satellite Analysis Branch (SAB). The details of these procedures are described in the NESDIS/NWS Satellite Schedule Coordination and Dissemination Procedures Plan which is available on the SSD web site (*www.ssd.noaa.gov*) for government users and selected other users, like SSEC, CIRA, and COMET. Click on "Satellite Schedule Coordination and Dissemination Procedures."

3.2.1.1.1.2 Special Products. Requirements for GOES dissemination schedules (special products) are coordinated and provided through the NESDIS Satellite Services Division (SSD) and are described in the NESDIS/NWS Satellite Schedule Coordination and Dissemination Procedures provided by the Satellite Services Division by calling 301-763-8051 or on the Internet at *www.ssd.noaa.gov/satops.*

3.2.1.1.2 GOES Imager and Sounder. GOES-8 and GOES-10 host an imager capable of detecting atmospheric temperature and moisture measurements in five spectral bands at high resolutions, including the new 3.9 micron and 12.0 micron wavelengths. GOES-8 and GOES-10 also have the feature of transmitting these five spectral bands simultaneously, affording the user community continuous views of atmospheric measurements in various wavelengths, each with its own meteorological and hydrological applications. The five channels and respective resolutions are as follows:

- Channel 1 (Visible, 0.55 to 0.75 microns) - one kilometer resolution.
- Channel 2 (Infrared, 3.8 to 4.0 microns) - four kilometer resolution.
- Channel 3 (Water vapor, 6.5 to 7.0 microns) - eight kilometer resolution.
- Channel 4 (Infrared, 10.2 to 11.2 microns) - four kilometer resolution.
- Channel 5 (Infrared, 11.5 to 12.5 microns) - four kilometer resolution.

The sounder on GOES-8 and GOES-10, consisting of 19 spectral channels, is used for measurements of atmospheric temperature and moisture profiles, surface and cloud-top temperature, and ozone distribution. Products derived from the sounder include precipitable water and the lifted index--a measure of atmospheric instability. Comparable to the imager, the sounder is capable of providing various scan coverages, such as full earth imagery, sectorized imagery, and local imagery. An independent sounder platform, governed under its own schedule, provides an expansion of sounder data coverage and an increase in the frequency of transmissions. GOES-8 and GOES-10 also carry vital subsystems; such as, the SEM, DCS, WEFAX, and SAR operations.

3.2.1.1.3 GOES Products. Under the NESDIS support concept, satellite imagery, in support of the *National Winter Storms Operations Plan*, is distributed by the Environmental Satellite Distribution/Interactive Processing Center in Camp Springs, Maryland, to the national centers (NCEP), NWS field offices, and to the Satellite Analysis Branch (SAB) and other NESDIS units. Data from the polar-orbiting satellites is available to SAB and the NCEP national centers, but not to NWS field sites.

NESDIS operates 24 hours a day to provide a myriad of satellite services and products to NCEP and NWS field sites. Internally at the NOAA Science Center, SAB meteorologists provide satellite interpretation and analyses to NCEP meteorologists, relating valuable information on present locations and intensities of winter storms, as well as the projected movement and development of all these storms. In addition, snowfall estimates are derived from satellite signatures and reported to NCEP and the NWS field sites to assist forecasters in determining fall rates and projected accumulations. As conditions warrant, winter storm precipitation analyses and estimates are disseminated to the appropriate NWS forecast offices and River Forecast Centers (RFC) across the United States.

All WFOs have access to the digital GOES data stream through AWIPS workstations. The satellite data feed to AWIPS/NOAAPORT is performed at the Satellite Central Data Distribution Facility (CDDF) in Camp Springs, MD. A large amount of satellite data are also available on a number of web site servers, both government operated and in the private sector.

The principal GOES-8 and GOES-10 products (see Table 3-1) are half-hourly pictures with navigation and calibration files included. During daylight hours, one, two, four, and eight kilometer resolution visible fixed standard sectors are produced for AWIPS/NOAAPORT distribution. Equivalent infrared sectors (4 kilometer), including water vapor (8 kilometer), for all available channels are available 24 hours a day. Satellite raw and remapped imagery, with navigation and calibration, is available to RAMSDIS users within the NWS and NESDIS community. Using the 3.9 micron and 10.7 micron channels together, a low-level cloud/fog product is produced, which the WFOs now use routinely. This is a new capability since these were the first geostationary satellites to use the 3.9 micron channel.

3.2.1.1.4 24-Hour Points of Contact.

- NCEP/NCO Senior Duty Forecaster (SDM)--301-763-8298
- NCEP/HPC Senior Branch Forecaster--301-763-8201
- NESDIS/SAB--301-763-8444

3.2.1.2 NOAA Polar-Orbiting Satellites. Each of these satellites crosses the U.S. twice per day at 12-hour intervals near the equatorial crossing times listed in Table 3-1. The current primary polar-orbiting satellites are NOAA-12, NOAA-14, and NOAA-15. Older satellites on orbit still have limited capabilities. NOAA-15 provides the same capabilities as previous NOAA satellites, plus an Advanced Microwave Sounder Unit (AMSU) was added. As of August 1, 2000, the AVHRR instrument on NOAA-12 has been used in place of the NOAA-15 AVHRR because of problems with NOAA-15's AVHRR instrument. NOAA-16 was launched on September 21, 2000, and has the same capabilities as NOAA-15.

3.2.2 Department of Defense (DOD) Defense Meteorological Satellite Program (DMSP). The DMSP constellation consists of at least two spacecraft placed in sun-synchronous orbits best suited to support military operations. In addition to the very high resolution visible and infrared imagery, DMSP provides a variety of remotely sensed terrestrial and space environmental data. A suite of microwave radiometers provides microwave imagery as well as surface characteristics and upper air temperature and moisture soundings. The DMSP data capabilities in the area of concern are provided in Table 3-1. Special requests for DMSP support will be addressed to CARCAH.

Table 3-1. Satellites and Satellite Data Availability for the National Winter Storms Operations Plan.

Geosynchronous Orbit

SATELLITE	TYPE OF DATA	LOCAL TIME	REMARKS
GOES-8 at 75°W GOES-9 at 106°W (on orbit storage) GOES-10 at 135°W GOES-11 at 104°W (on orbit storage)	Multispectral Imager and Sounder 5 channels for the Imager 19 channels for the Sounder	Every 30 minutes, in Routine Scan Mode, provides 3 sectors with prescribed coverages: Northern Hemisphere (NH) or Extended NH, CONUS or PACUS, and Southern Hemisphere (SH). Exception is transmission of a full disk every 3 hours. Available Rapid Scan Operations (RSO) yield increased transmissions to 7.5 minute intervals to capture rapidly changing, dynamic weather events.	1. 1, 2, 4, and 8 km visible standard sectors. 2. 4 km equivalent resolution IR sectors. 3. Equivalent and full resolution IR enhanced imagery. 4. Full disk IR imagery every 3 hours. 5. 8 km resolution water vapor sectors. 6. Quantitative precipitation estimates, high density cloud and water vapor motion wind vectors, and experimental visible and sounder winds. 7. Operational moisture sounder data (precipitable water) in four levels for inclusion in NCEP numerical models. Other sounder products include: gradient winds, vertical temperature and moisture profiles, mid-level winds, and derived product imagery (precipitable water, lifted index, and surface skin temperature. 8. Tropical storm monitoring and derivation of intensity analysis. 9. Volcanic ash monitoring and dissemination of volcanic ash advisory statements. 10. Daily Northern Hemisphere snow cover analysis. 11. Twice daily fire and smoke analysis over specific areas within CONUS.

Polar Orbiting

SATELLITE	TYPE OF DATA	LOCAL TIME*	REMARKS
NOAA-15	AVHRR (experiencing difficulties) GAC and LAC (recorded) HRPT and APT (direct) RTOVS and AMSU	0729D/1929A	1. 1 k m resolution HRPT/ Local Area Coverage (LAC) data. 2. 4 km resolution APT/ Global Area Coverage (GAC) data. 3. Mapped imagery. 4. Unmapped imagery (all data types) at DMSP sites. 5. Sea-surface analysis. 6. Soundings. 7. Moisture profiles. 8. Remapped GAC sectors. 9. Sounding-derived products: total precipitable water, rain rate, and surface winds under sounding (NOAA-15). 10. Daily northern hemisphere snow cover analysis 11. Twice daily fire and smoke analysis over specific areas within CONUS.
NOAA-14	Same as NOAA-15, except no AMSU	0403D/1603A	
NOAA-12	AVHRR , GAC and LAC (recorded) HRPT and APT (direct), TOVS	0519D/1719A	
DMSP F-15	OLS Imagery (recorded and direct) SSM/I, SSM/T-1, SSM/T-2	0925D/2125A	1. 0.3 nm (regional) and 1.5 nm (global) resolution (visual and infrared) imagery available via stored data recovery through AFWA. 2. Regional coverage at 0.3 nm and 1.5 nm (visual and infrared) imagery available from numerous DOD tactical terminals. 3. SSM/T-1, SSM/T-2, and SSM/I data transmitted to NESDIS and FNMOC from AFWA.
DMSP F-14	Same as F-15, except SSM/T-1 non-functional	0845D/2045A	
DMSP F-13	Same as F-15, except no SSM/T-2	0600D/1800A	
DMSP F-12	Same as F-15, except SSM/I and SSM/T-1 non-functional	0820D/2020A	

* Local time/equatorial crossing time/D = Daylight descending/A = Daylight ascending

3.3 Automated Coastal Marine and Ocean Observations.

3.3.1 Moored Data Buoys and Coastal Marine Automated Network.

3.3.1.1 Procedures. Moored buoy and C-MAN stations routinely acquire and transmit data every hour. Buoy observations include sea-level pressure, wind speed, peak 5-second wind, wind direction, air temperature, sea-surface temperature, significant wave height and period, and wave spectral data. A description of the data from a typical moored buoy payload is provided in Table 3-2; data from a typical C-MAN station are shown in Table 3-3. Refer to figures 3-1, 3-2, and 3-3 for the locations and station identifiers of moored buoys and C-MAN stations. Consult NDBC's web site at *www.ndbc.noaa.gov* for the latest station status or more site-specific information.

3.3.1.2 Communications. Data are transmitted by ultra-high frequency (UHF) communications via the GOES satellite to NESDIS and then are relayed to National Weather Service Telecommunications Gateway (NWSTG) for processing and dissemination. Data from moored buoys are formatted into World Meteorological Organization (WMO) FM13-IX SHIP code. From C-MAN sites, the data are formatted in a modified form of the FM12-IX SYNOP code.

3.3.1.3 Point of Contact (Daytime). The NDBC Data Analyst can be reached at 228-688-3134.

3.3.2 Drifting Data Buoys.

3.3.2.1 Procedures. These buoys are deployed by ship or aircraft in data-sparse areas. Their movements are largely dependent upon ocean currents and winds. Data available include position, sea-level pressure, wind speed and direction, air temperature, and sea-surface temperature. Several drifting buoys were deployed in the North Central Pacific by AES Canada. They are expected to continue transmitting through the winter of 2001. Additional drifting buoys are expected to be deployed by AES in 2001to maintain an observation network.

3.3.2.2 Communications. Data are transmitted by UHF communications via the NOAA polar-orbiting satellites to NESDIS ground receiving stations and then relayed to the U.S. Argos Global Processing Center in Landover, Maryland, and to the NWSTG for processing and dissemination. Data from drifting buoys are formatted into WMO FM18-IX BUOY code.

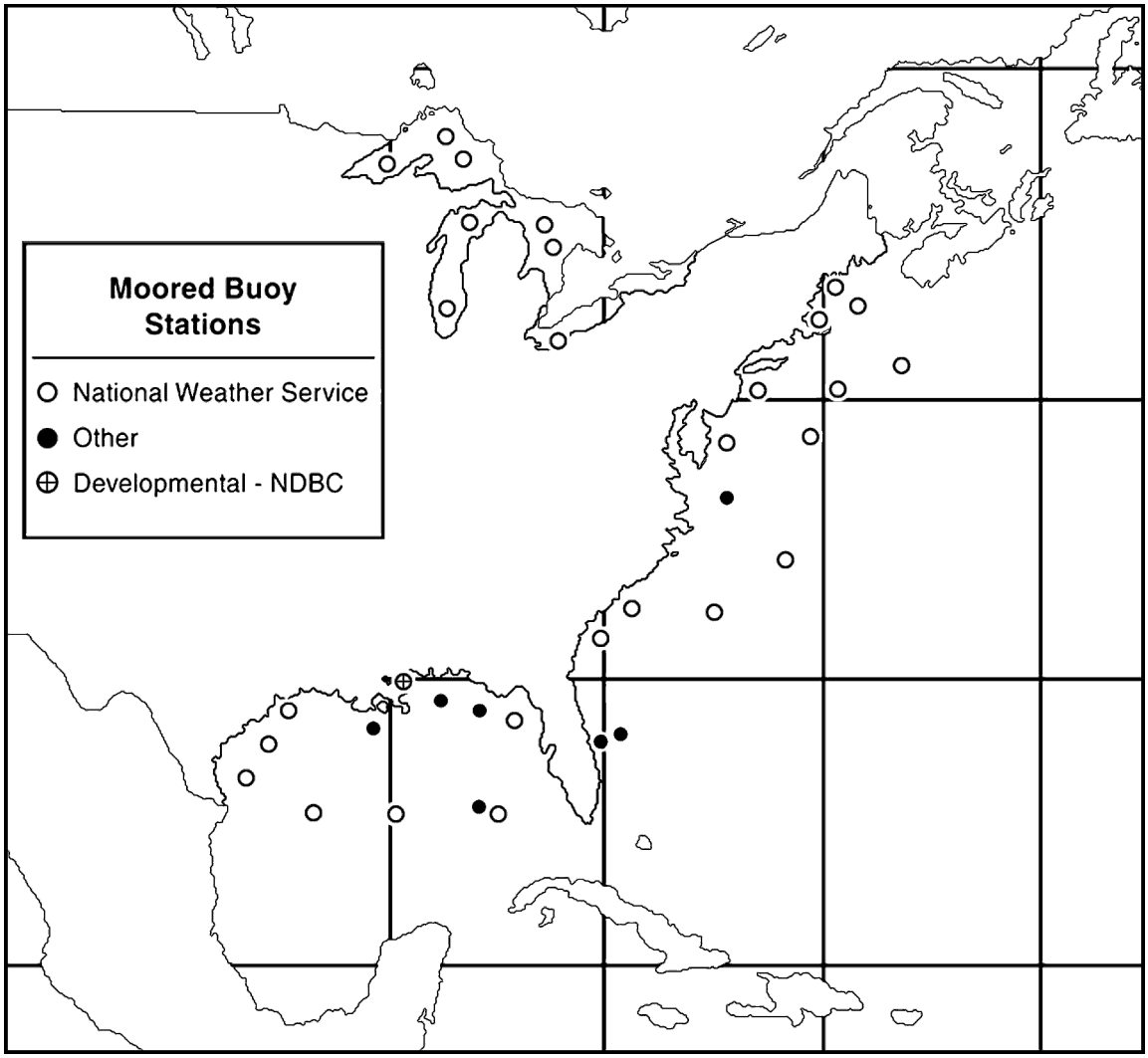

Figure 3-1. Map showing the location of NDBC moored buoys - Atlantic basin.

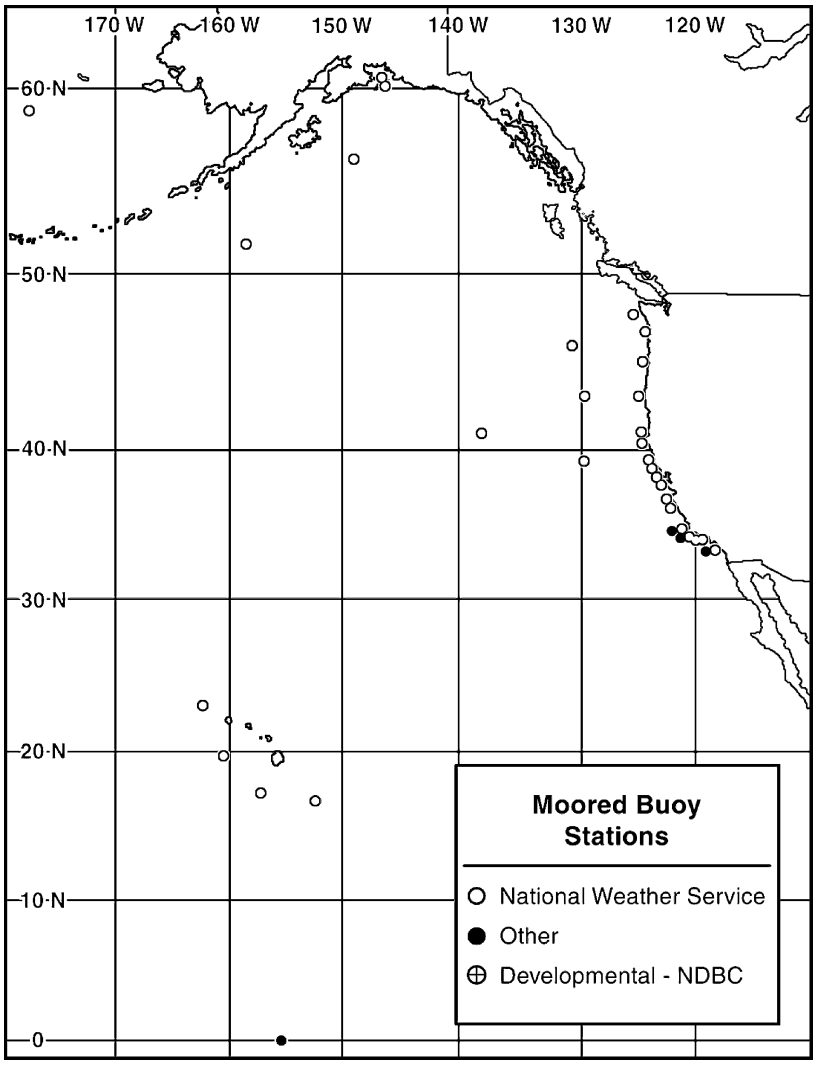

Figure 3-2. Map showing the location of NDBC moored buoys - Pacific basin.

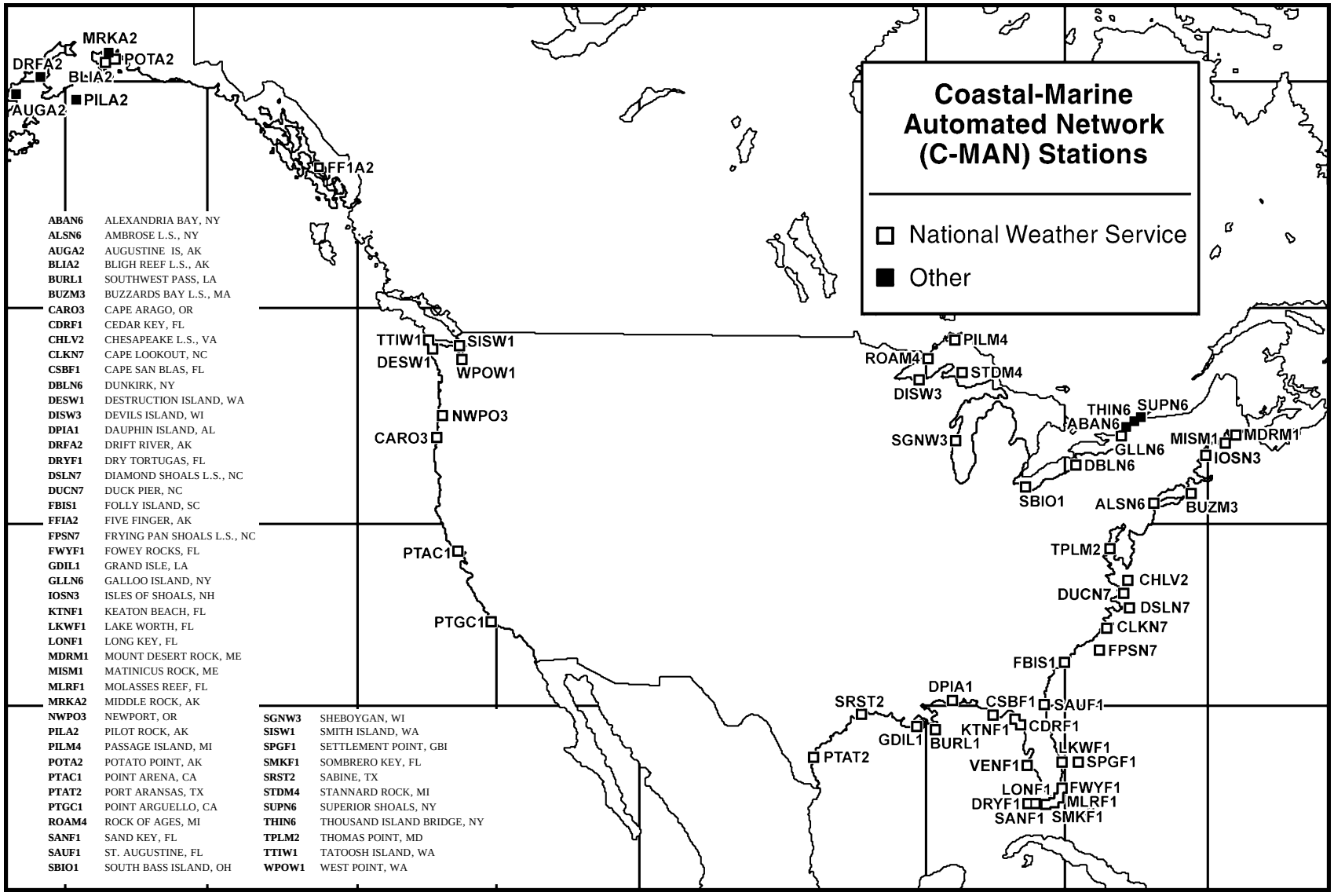

Figure 3-3. Map showing the location of NDBC fixed C-MAN stations in North America, including USCG Navigational Buoys.

Table 3-2. Moored buoy payload data.

PARAMETER	REPORTING RANGE	REPORTING RESOLUTION	SAMPLE INTERVAL	SAMPLE PERIOD	TOTAL SYSTEM ACCURACY
WIND SPEED	0 TO 60 m/s	0.1 m/s	1 s	8 min	±1 m/s or 10%
WIND DIRECTION	0 TO 360°	1°	1 s	8 min	±10°
PEAK WIND	0 TO 82 m/s	1 m/s	1 s	5 s	±1 m/s or 10%
AIR TEMPERATURE	-30 TO 70 °C	0.1 °C	90 s	8 min	±1 °C
ATMOSPHERIC PRESSURE	800 TO 1100 hPa	0.1 hPa	4 s	8 min	±1 hPa
SEA SURFACE TEMPERATURE	-7 TO 41 °C	0.1 °C	1 s	8 min	±1 °C
SIGNIFICANT WAVE HEIGHT	0 TO 35 m	0.1 m	0.39 s	20 min	±0.2 m or 5%
WAVE PERIOD	3 TO 30 s	0.1 s	0.39 s	20 min	±1 s
NONDIRECTIONAL WAVE SPECTRA	0.03 TO 0.40 Hz	0.01 Hz	0.39 s	20 min	—
DEW POINT TEMPERATURE*	-35 TO 30 °C	0.1 °C	1 s	8 min	±1 °C
SOLAR RADIATION*	0 TO 2150 W/m^2	0.5 W/m^2	1 s	8 min	±5%
PRECIPITATION RATE*	1 TO 1600 mm/hr	1 mm	1 s	15 min	±5%
DIRECTIONAL WAVES*	0 TO 360°	1.0°	0.5 s	20 min	±5°
OCEAN CURRENTS (ADCP)*	0 TO 1000 cm/s	0.5 cm/s	1.5 s	20 min	±2 cm/s

*PARAMETER REPORTED ON SELECTED BUOYS

Table 3-3. Data from a typical fixed C-MAN station.

MEASURANDS	REPORTED DATA	REPORTING RANGE	REPORTING RESOLUTION	MINIMUM AVERAGING PERIOD (SELECTABLE)	TOTAL SYSTEM ACCURACY
WIND DIRECTION	TRUE WIND DIRECTION	0° – 360°	1.0°	2 min	±15° TRUE (±10° DESIRED)
WIND SPEED	AVG. WIND SPEED	0 – 120 kn	1.0 kn	2 min	±2.0 kn or 5%
	PEAK WIND GUST	0 – 160 kn	1.0 kn	(SELECTABLE)	±2.0 kn or 5%
WAVES	SIGNIFICANT WAVE HEIGHT (H_a)	0 – 49 m	0.5 m	(SELECTABLE)	0.5 m
	WAVE PERIOD (T)	2.5 – 5 s	1 s	(SELECTABLE)	±1 s
	PROBABLE MAXIMUM WAVE HEIGHT	0 – 49 m	0.5 m	(SELECTABLE)	0.5 m
BAROMETRIC PRESSURE	SEA LEVEL PRESSURE	900 – 1100 hPa	0.2 hPa	2 min	±1.0 hPa ABSOLUTE
AIR TEMPERATURE	AIR TEMPERATURE	-30 to +70 °C	0.1 °C	1 min	±1.0 °C
SEA SURFACE TEMPERATURE*	SEA SURFACE TEMPERATURE	-6 to +40 °C	0.5 °C	1 min	±1.0 °C
DEW POINT*	DEW POINT TEMPERATURE	-35 to +30 °C	0.5 °C	1 min	-35 to -24°C: ±2 °C -23.5 to -1.5°C: ±1.5 °C -1.5 to +30 °C: ±1.0 °C
SECTOR VISIBILITY*	VISIBILITY RANGE	0 – 8 statute mi		2 min	0 to 3 mi: ±10% 3 to 8 mi: ±1 mi
WATER LEVEL*	WATER LEVEL	0 – 99.99 ft	0.01 ft	(PERIODICALLY RESET TO ZERO)	TBD

* PARAMETER REPORTED ON SELECTED STATIONS